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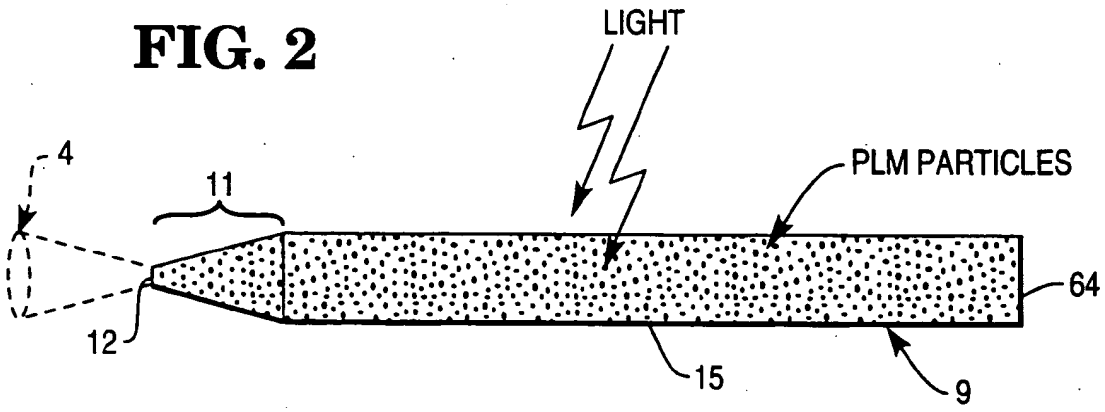
(54) **Light pen.**

(57) The invention provides for a light pen for a computer, which comprises an elongate body member (9,76) which contains a photoluminescent material (PLM). The PLM absorbs ambient light of one wavelength, and radiates light of another wavelength in response. The radiated light is directed so as to be projected from a tip (12,78) as required.

FIG. 2



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The present invention relates to a pen-like device having a light output, hereinafter referred to as a light pen.

Light pens are commonly used as input devices for data processing and storage systems in place of conventional keyboards and mouse devices. A light pen is used in combination with a display screen incorporating a photosensitive digitizer or photosensitive sheet material. As such, information can be input by writing with the light pen on the screen and typically the screen displays the instantaneous position, and path of movement, of the pen. In this way, the screen displays the pattern, e.g. a written message, sketch or signature traced thereon.

The light source for known light pens disadvantageously comprises a relatively fragile lamp or L.E.D. which can readily suffer damage if the pen is dropped. The light source is powered either by way of a power supply cord or cable or by way of a battery if a "cordless" light pen is required. The power is supplied by way of electrical connections which may also be fragile and prone to breakage if the pen is dropped or otherwise misused. Such components are generally expensive to purchase and assemble.

Cordless light pens are advantageous in that the movement and use of the pen is not impaired by a cord which can easily become snagged or otherwise interfere with the light pen. Also, a single cordless light pen can be used with a plurality of digitizer units, or other devices, since the pen is not anchored to one unit by a power supply cord.

However, known cordless light pens suffer particular disadvantages in that a battery must be provided for their use, which increases the operating cost of such pens. If a replaceable battery is used, this further increases the cost and also makes operation of the pen dependent on the availability of a replacement battery. If a re-chargeable battery is employed this may also lead to an increase in the "down time" for the pen, i.e. the period during which the pen can not be used.

It is an object of the present invention to provide a light pen which does not exhibit the above-mentioned disadvantages.

According to the present invention there is provided a light pen having an elongate body member with a tip from which light is output, characterized in that said body member and includes photoluminescent material, whereby light radiated by said photoluminescent material in response to external light is directed by a process of internal reflection to said tip for output therefrom.

In obtaining its light output from the ambient light it receives, the pen of the present invention is advantageously less costly to operate than those of the prior art and also the "down time" experienced by known light pens is eliminated. Also, the light pen of the invention does not require electrical connections and relatively fragile components such as lamps and L.E.Ds, so that a light pen having improved mechanical strength, and thus resistance to accidental damage, is provided.

The invention is described further hereinafter, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 illustrates the use of a known light pen for generating an input to a computer;

Fig. 2 illustrates a light pen according to one embodiment of the present invention;

Fig. 3 illustrates the use of two different types of anti-reflective coatings, namely, on the body of the light pen of Fig. 2 and at the tip of the light pen of Fig. 2;

Fig. 4 illustrates how some rays escape from the light pen of Fig. 2;

Fig. 5A illustrates a radial -gradient-index lens for use with a light pen embodying the present invention;

Fig. 5B illustrates an axial-gradient-index lens for use with a light pen embodying the present invention;

Fig. 5C illustrates a "radial gradient.";

Fig. 5D illustrates the refraction of a light ray passing between materials of different refractive indices;

Fig. 6 illustrates one way to construct the radial-gradient-lens of Fig 5A;

Figs. 7A and 7B illustrate a light pen according to a further embodiment of the present invention.

Fig. 8 illustrates intensity-versus-time plots of various phtoluminescent materials;

Fig. 9 illustrates a stand, and a light source, for charging a light pen embodying the present invention;

Fig. 10 illustrates how a video display can be used as a light source for charging a light pen embodying the present invention; and

Fig. 11 illustrates a reflector for use in charging a light pen embodying the present invention.

One type of known light pen is shown in Fig. 1. The pen 1 detects the position of a spot of light, thereby allowing a computer to obtain data from the pen, based on the position of the spot.

For example, the display may show a series of boxes, as indicated, each of which indicates a different option for the user to select. The user selects an option by placing the spot of light into the proper box. The display detects which box contains the light spot, and thus recognizes the choice made by the user.

Fig. 2 shows a rod 9, constructed of a transparent material, polymethyl methacrylate (PMMA), containing particles of a photoluminescent material (PLM). The PLM absorbs ambient light, as indicated. The absorption

promotes electrons in the PLM to higher energy states which then fall to lower states, causing the PLM to radiate light. Part of the radiated light is reflected internally at the interface between the rod 9 and air so as to travel towards a bevelled end 11 of the rod, where it exits through a facet 12 forming the tip of the bevelled end 11.

In order to increase the absorption of ambient light, an anti-reflective coating is applied to the external surface 15 of the pen. Also, a reflective coating can be employed on the end 64 of the pen opposite the tip 12 so as to direct light, travelling away from the tip, back towards the tip.

Alternatively, the rod can be given a coating which acts as a high-pass filter. The incoming light will be of a shorter wavelength, and thus higher frequency, than the radiated light. The filter is transparent to the higher frequencies but blocks the radiated, lower frequencies and so enhances the total internal reflection within the pen.

The tip facet 12 of the pen in Fig. 2 may also be coated with a dielectric coating so as to maximize transmission. That is, the tip is coated to maximize transmission from the inside of the pen to the outside, and the body of the pen is coated to maximize transmission in the opposite direction namely from the outside to the inside of the pen. Fig. 3 illustrates this distinction.

As indicated in Fig. 4 a bevelled, conical end may not produce the light intensity required for a particular use. In general, for a reflected ray, the angle of incidence equals the angle of reflection. Rays 18 and 21 are reflected accordingly, and successfully escape the rod. However, ray 24 does not, and is reflected back into the rod.

If the apparatus employing the light pen requires a greater output then alternative embodiments of the invention could be used as discussed below.

A gradient-index lens could be used, as shown in Fig. 5A. The refractive index of this lens 72 is greater near the centre than near the surface, as indicated in Fig. 5C. This type of change in refractive index causes the rays to follow the bevelled tip, until they can escape at the very end of the tip. That is, the rays are continually bent towards the centreline C as they progress towards the tip.

One way to construct such a gradient-index cone is shown in Fig. 6. First, concentric cylinders of materials having different indices of refraction are assembled into a solid cylinder. Then, the solid cylinder is machined into a cone and the cone is then fastened to the rod using an adhesive.

An axial gradient-index-lens 74 can be used, as indicated in Fig. 5B. In this case, the index of refraction is greater close to the end 12A as indicated. The operation can be visualized by considering the gradient region as divided into sections, two of which are shown in Fig. 5D. Each ray is bent towards the line marked NORMAL (ie, the line perpendicular to the interface); angle X is greater than angle Y. Thus, the axial gradient of the lens of Fig. 5B directs the rays into substantially parallel configuration, which is parallel with the optical axis of the rod.

Another embodiment for increasing the light output is shown in Fig. 7B. In general, a plate containing the PLM does not change its internal reflection characteristics when rolled to form a wall 84 of a tube 76, as in Fig. 7A, so long as r (the radius) is equal to or greater than 3a (a is the tube wall thickness, as indicated).

Under these conditions, the diameter of the tube 76 can be continuously reduced toward one end to form a tip 78, thus providing the desired concentration of light. That is, as the diameter decreases, and thus "r" decreases, the wall thickness decreases as the tip 78 is approached. The end opposite the tip 78 can be terminated by a hemispherical cap 80 or a plane mirror 82, as indicated. Light rays which are not absorbed by the PLM during passage through the wall 84 and into the tube 76 may be absorbed as they again pass through the wall 84 on their passage towards the outside of the tube.

As a further alternative, the tube 76 and cone 78 of Fig. 7B could be filled with a solid or liquid material, provided such material has a lower refractive index than that of the tube wall 84.

The discussion above assumes particles of a photoluminescent material suspended in PMMA. The PMMA acts as a matrix material which supports the particles. However, it is not necessary to use PMMA as the supporting matrix; other transparent materials can be used. Further, the photoluminescent material need not be a particulate, but can, for example, be a liquid which is suspended in the matrix. Still further, the PLM can take the form of a solid in solution, or in suspension, in the matrix.

Photoluminescence is understood to occur by the following sequence of events: a material absorbs a photon, which creates an electron-hole pair (EHP) and, when the electron and hole recombine, light is radiated.

If the recombination is relatively fast, the process is termed "fluorescence" and if the recombination is relatively slow the process is called "phosphorescence.

Table 1 identifies several of the suitable PLMs which can be used.

TABLE 1

Photoluminescent Material	EHP Mean Lifetime	Absorbtion max	Emission max
PERYLENE 083	4.10^{-9} sec	476nm	490nm
PERYLENE 240	4.10^{-9} sec	524nm	539nm
PERYLENE 300	4.10^{-9} sec	578nm	613nm
NAPHTALIMIDE 570	4.10^{-9} sec	378nm	413nm

It may be desirable to combine a PLM which exhibits fluorescence with one which exhibits phosphorescence, in order to allow the pen to store light, and then project light after the incoming light becomes dimmer. For example, when the light pen is held in the hand, the incoming light is reduced, because the hand shadows the pen. If the pen contains only a fluorescent PLM, then the light projected by the pen will also be reduced.

If the particular application of the light pen requires that the light output should not decrease in the manner outlined above, the pen can contain several PLMs which exhibit radiation output curves of the type illustrated in Fig. 8. Some of the PLMs deplete their stored energy rapidly (ie. those which fluoresce), and some take a longer time for depletion (ie, those which phosphoresce). As such, the phosphorescent materials act as light-storage agents.

As Fig. 9 shows, a cradle 60 can be provided within which the light pen can rest. The pen snap-fits into the cradle. The cradle can contain a light source 63 which may also provide light which is more intense than ambient light, thus charging the multi-PLM light pen with more energy than would ambient light, or charging with the same energy in a shorter time.

If the device in which the pen is used has a light-producing display 2, the display can be employed to provide the light required to charge the light pen. The cradle can be located adjacent the display, as in Fig. 10. The computer is programmed, in a manner known in the art, to illuminate a region of the display with the appropriate colour, for charging the pen. For example, a white rectangle similar in size to the longitudinal cross-section of the pen, can be employed for charging it.

The use of two pens is also advantageous in that the additional pen is charged, while the other pen is being used. When the pen in use has exhausted its charge, the pens can be exchanged.

Further, the charging holder can take the form of a reflector 70 which concentrates ambient light, as indicated in Fig. 11.

Claims

1. A light pen having an elongate body member (9,76) with a tip (12,78) from which light is output, characterized in that said body member (9,76) includes photoluminescent material, whereby light radiated by said photoluminescent material in response to external light is directed by a process of internal reflection to said tip (12,78) for output therefrom.

2. A light pen according to claim 1, characterized in that said body member (9,76) is transparent.

3. A light pen according to claim 1 or claim 2, characterized in that said body member comprises a solid body member (9) having a lens means (72,74) with a graded refractive index adjacent said tip (12,78).

4. A light pen according to claim 3, characterized in that the refractive index of said lens means (72) is graded in a direction perpendicular to the optical axis of said pen.

5. A light pen according to claim 3, characterized in that the refractive index of said lens means (74) is graded in the direction of the optical axis of said pen.

6. A light pen according to claim 1 or claim 2, characterized in that said body member comprises a hollow body member (76) having a wall member (84,86) including said photoluminescent material.

7. A light pen according to claim 6, characterized in that said wall member (84,86) is tapered at one end (72) so as to form said tip (78).

8. A light pen according to any one of the preceding claims, characterized in that said body member (9,76) includes a first photoluminescent material which is fluorescent and a second photoluminescent material which is phosphorescent.

9. A light pen according to any one of the preceding claims, characterized in that substantially the whole outer surface of said body member (9,76) is arranged to receive external light for exciting said photoluminescent material.

10. A light pen according to any one of the preceding claims, characterized in that the outer surface of said body member (9,76) is coated with a material to enhance the total internal reflection of the light radiated by said photoluminescent material.

11. A light pen according to any one of the preceding claims, characterized in that said body member (9,76) is formed of a transparent plastic material having particles of photoluminescent material embedded therein.

FIG. 1

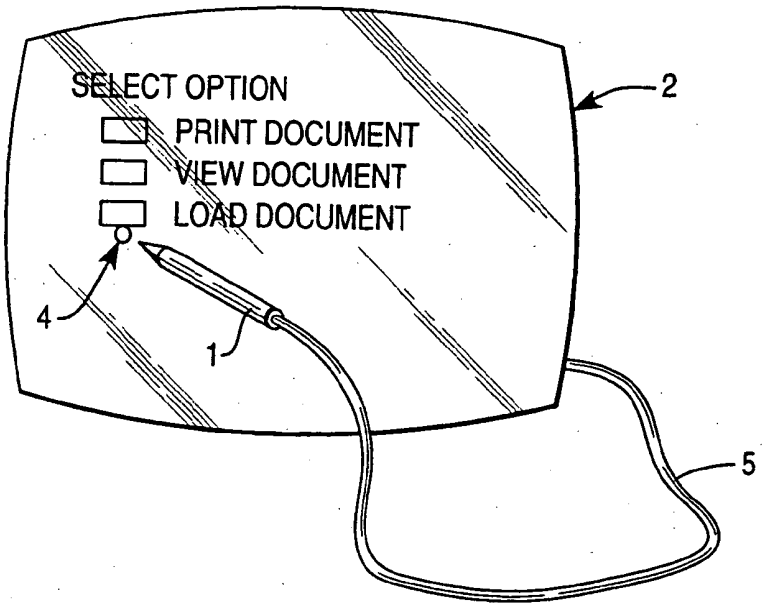


FIG. 2

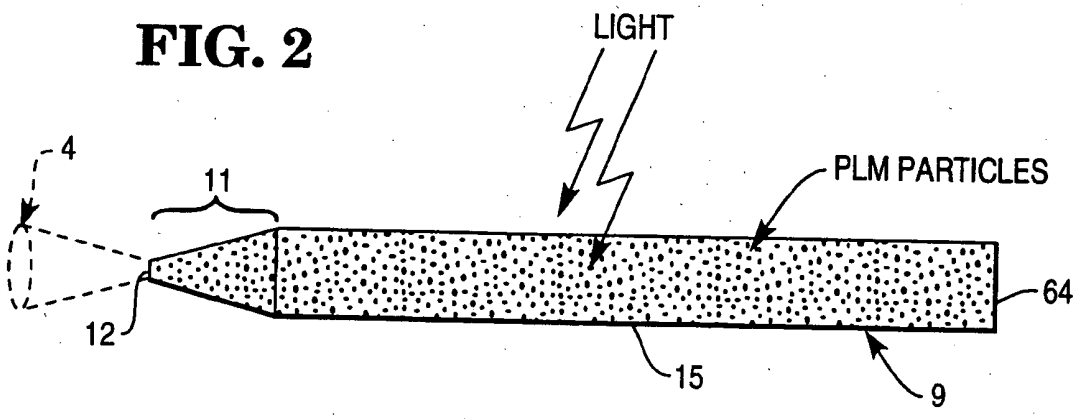


FIG. 3

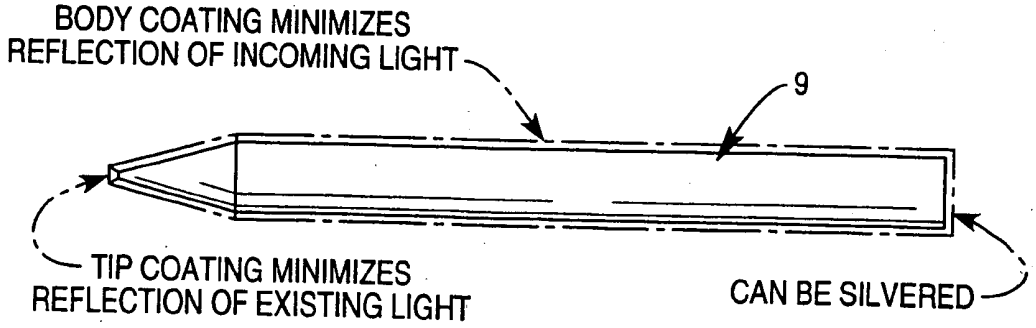


FIG. 4

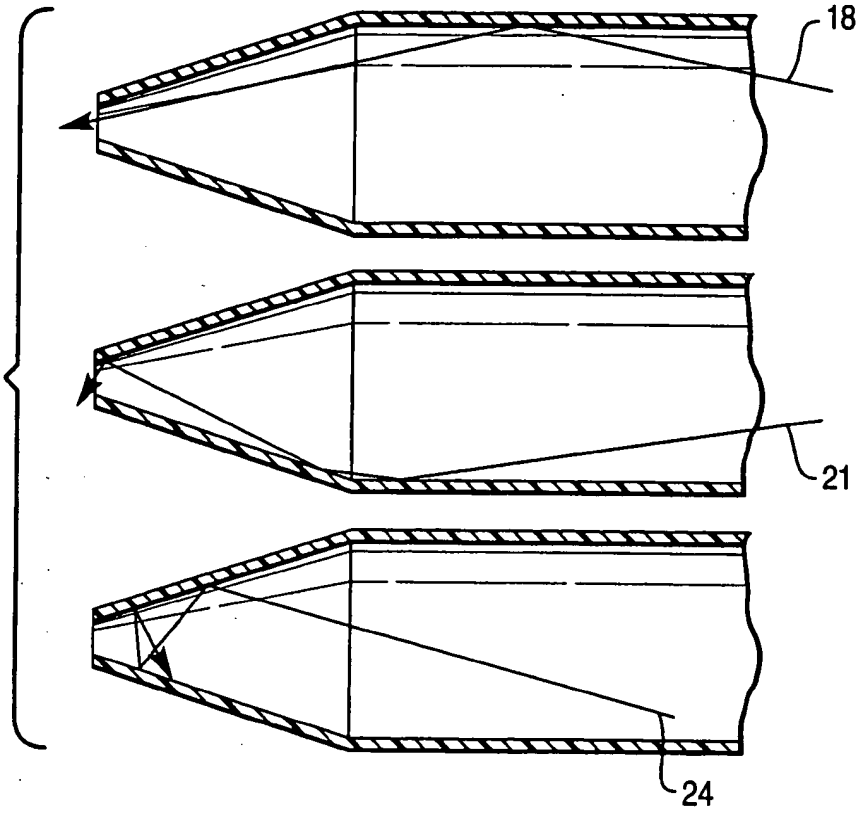


FIG. 5A

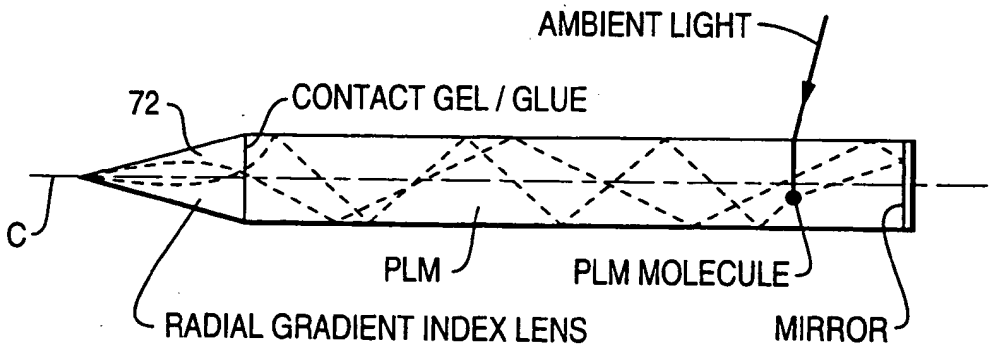


FIG. 5B

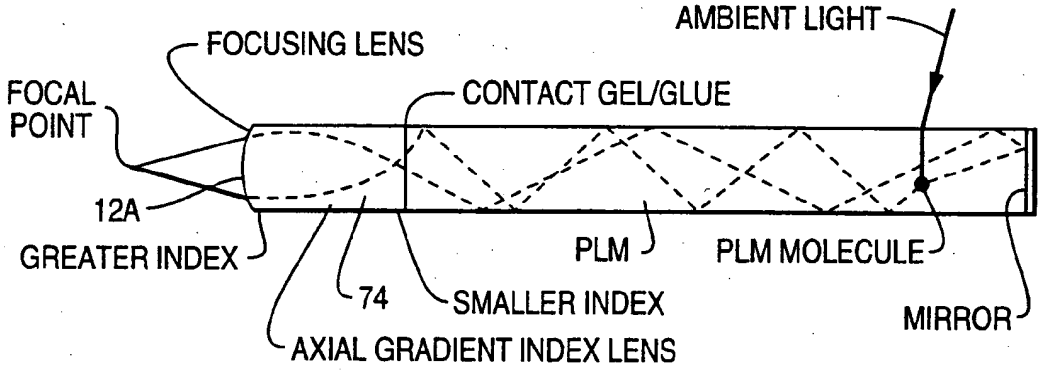


FIG. 5C

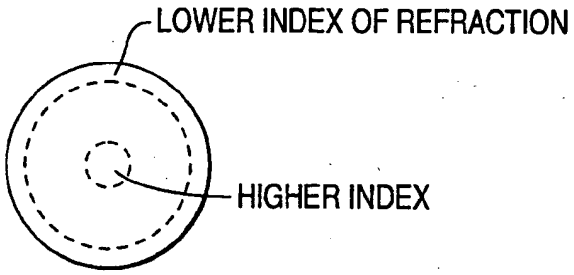


FIG. 5D

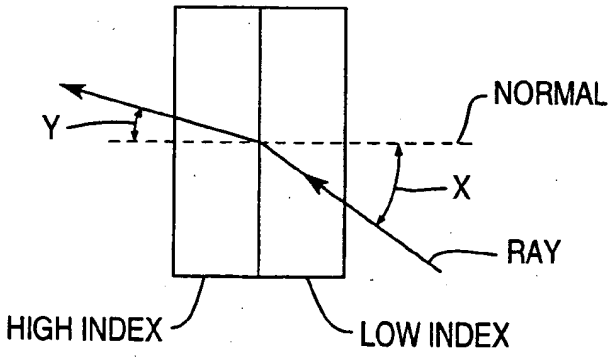


FIG. 6

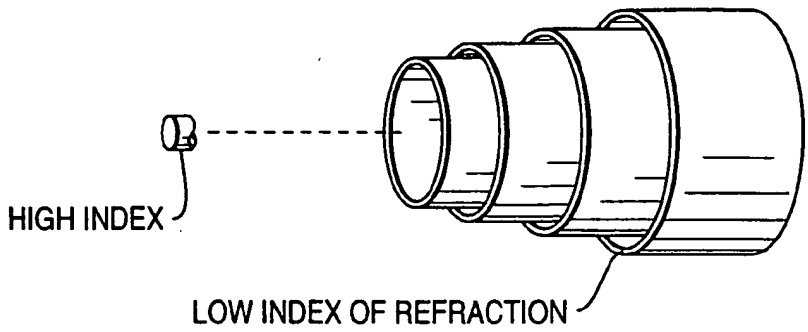


FIG. 7A

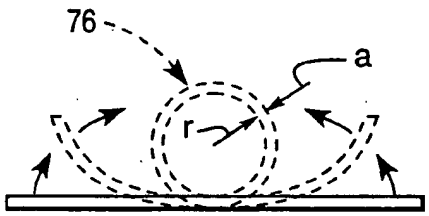


FIG. 7B

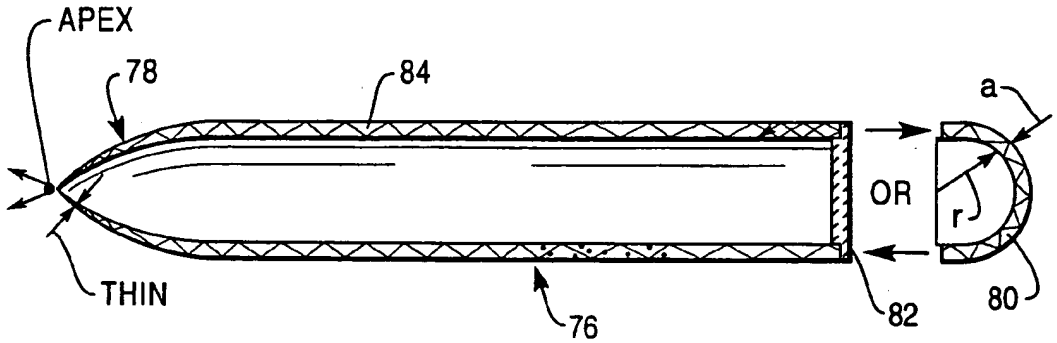


FIG. 8

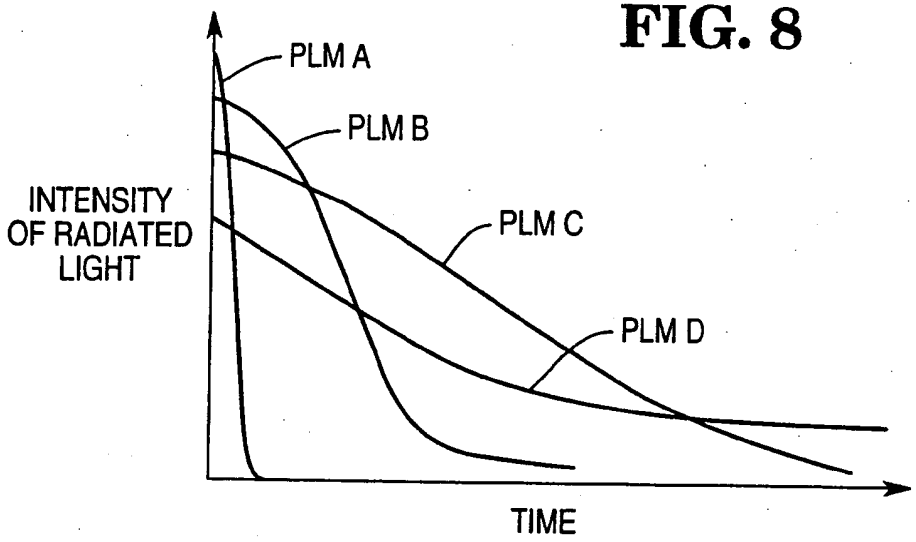


FIG. 9

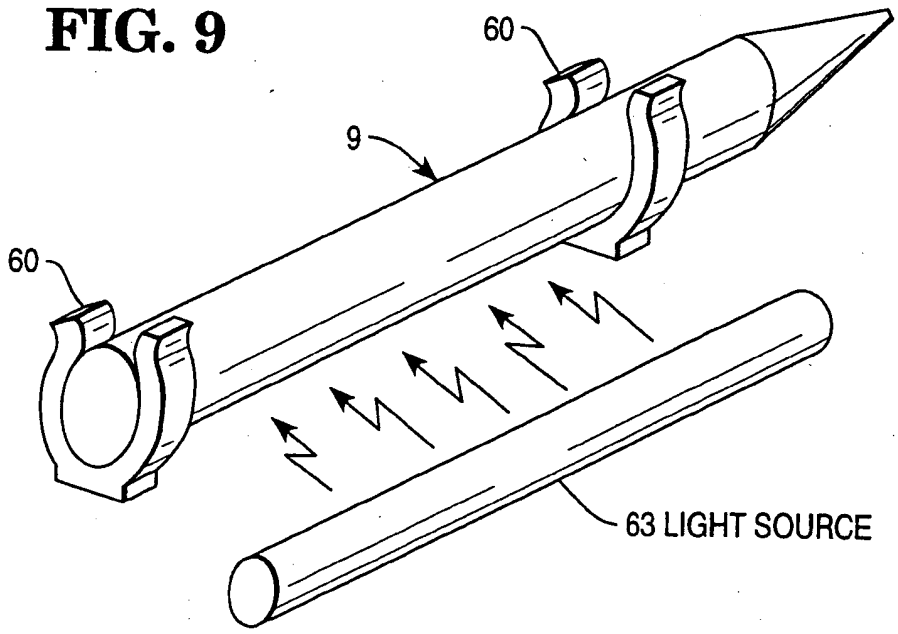


FIG. 10

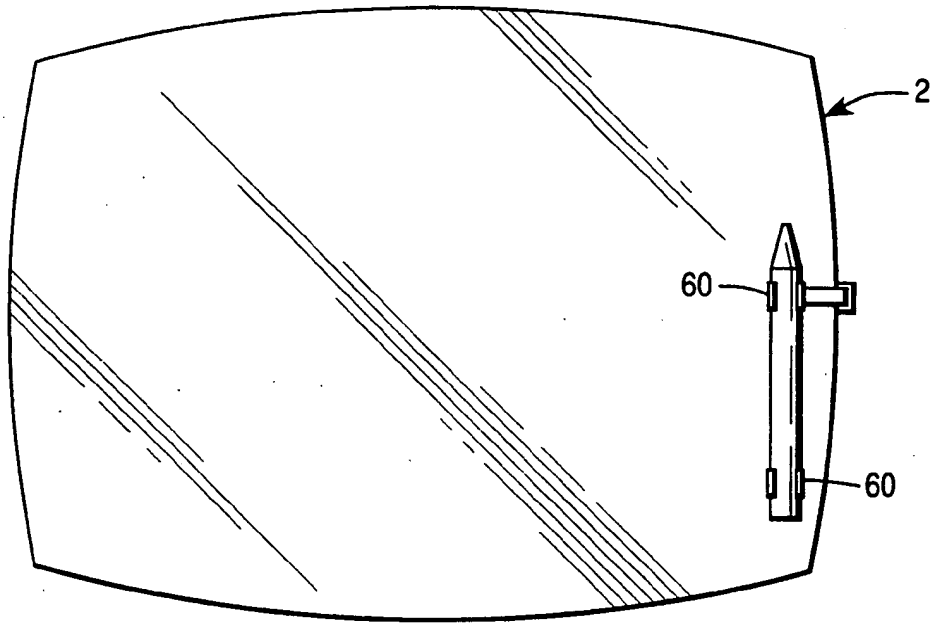
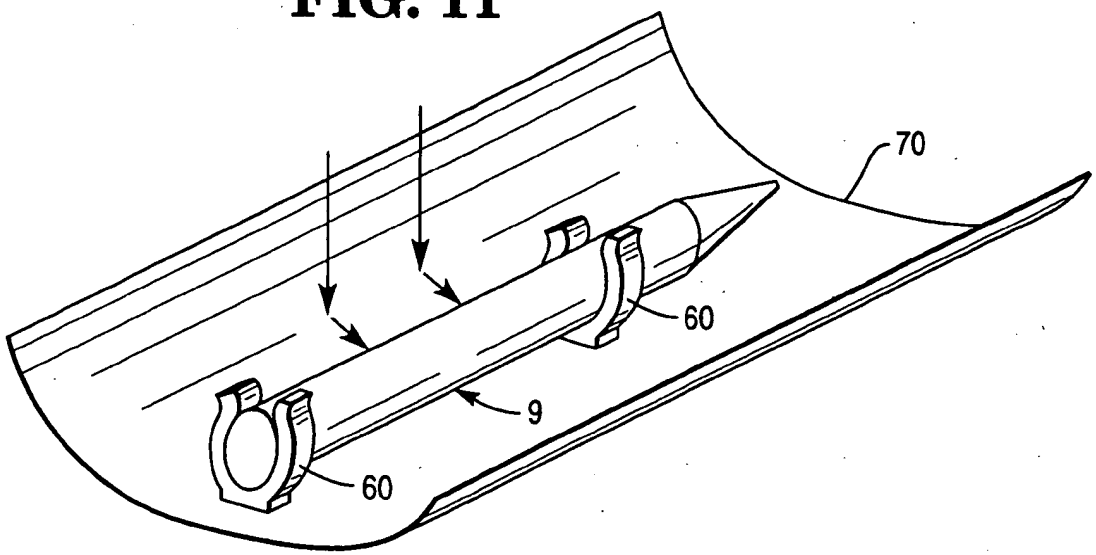


FIG. 11



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 30 7821

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	PATENT ABSTRACTS OF JAPAN vol. 008, no. 157 (P-288)20 July 1984 & JP-A-59 053 974 (IKEGAMI) 28 March 1984 * abstract *	1,10	G06K11/18
A	---	3,8	
A	EP-A-0 236 731 (BBC AKTIENGESELLSCHAFT) * column 2, line 18 - line 32 * * column 3, line 44 - column 5, line 9; figure 2 * -----	1,2,6,7, 9,10	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

G06K
G06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 February 1994	Semple, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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